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STUDY OF A MOUNTAIN PINE BEETLE INFESTATION IN LODGEPOLE PINE

By
A. L. Gibson
Assistant Entomologist

Forest Insect Laboratory
Coeur d'Alene, Idaho
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Introduction

This report is a continuation of the "Report of the Surveys of the Mountain Pine Beetle Infestation on the Beaverhead National Forest". Until 1933 we were chiefly concerned with the study of the development of the large outbreak of the mountain pine beetle in lodgepole pine on the Beaverhead Forest, but with the decided decrease in that infestation in 1933 and, except in 1934, further decreases since 1933, other phases have assumed greater importance.

The light infestation remaining on the main Beaverhead Forest is now confined to its eastern part. Status of insect activity in 1937 in the Big Hole Basin was determined from the Battlefield check strip and from two other strips run on the west side of the basin; for the rest of the Beaverhead from survey strips, two check strips, and general observation.

Present Status of the Infestation on the Beaverhead National Forest

Except in 1934, when a slight increase occurred, the general trend of the infestation on the Beaverhead Forest since 1933 has been downward. Furthermore, the infestation has died out on the portions of the forest where it did its greatest damage and is confined now to the Melrose and Rattlesnake Units, with possibly a few patches of infested whitebark pine at high elevations on the Grasshopper and

Upper Wise River units. Now the outbreak is below even the amount estimated at the time the survey was initiated in 1927, when 46,601 trees were reported. The total infestation increase or decrease over preceding years and percent of change are given for the period from 1927 to 1937 in table I.

Table I

CHANGES IN MOUNTAIN PINE BEETLE INFESTATION
BEAVERHEAD NATIONAL FOREST

Number of Trees Attacked by the Mountain Pine Beetle										
1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937
67,691*	722,504	3,119,542	4,898,326	15,402,520	17,586,171	869,647	1,282,510	255,632	147,725	31,170
Increase:	654,813	2,397,038	1,778,784	10,504,194	2,183,651		412,863			
Decrease:						16,716,524		1,026,878	107,907	116,555
Percent change	957	332	57	214	14	-95	47	-80	-42	-79

* Estimate considered to have been too conservative; also 55,045 of these trees were treated in 1928. All data subsequent to 1927 corrected for effect of difference in date of survey on total infestation for each year.

In general, the few lodgepole pine infested by the mountain pine beetle contained a light brood and a majority of these attacked trees had "pitched-out" the invading insects or showed a heavy "fill-in" of secondary bark beetles including Pityogenes knechteli, Pityophthorus burkei, Ips radiatae, and Ips oregoni. Of these small bark beetles Pityogenes knechteli is by far the most abundant, while the others are comparatively few and of minor importance. In whitebark pine the mountain pine beetle attacks as usual were heavier than in lodgepole pine and contained fewer secondary bark beetles.

On a few areas a concentration of bark-beetle activity had resulted from damage to trees because of unseasonal temperatures. One such area is on Birch Creek, where during both 1936 and 1937 this damage has been followed by defoliation and consequent weakening of the lodgepole pine. The mountain pine beetle has attacked many of these trees, and of these about 20 percent contained a heavy brood; the remainder a light brood, a "pitched-out" attack, or a heavy "fill-in" of secondary bark beetles on a more or less light mountain pine beetle attack. These smaller, secondary bark beetles have attacked even more weakened trees than the primary beetle. Losses on this 200-acre area from the smaller bark beetles may be expected to continue and probably heavy broods develop until the weakened material is exhausted. Subsequently the development of the infestation is a matter of conjecture. If the potential increase in brood of the primary beetle in these weakened trees materializes, considerable loss in the adjoining undamaged timber could result.

and there is the further possibility the present waning infestation may be revived. On Rock Creek a few miles to the north a similar condition exists, except that defoliation has not been as heavy and occurred only in 1937.

The change in status of the infestation during the period of the surveys is shown in table II.

Table II

COMPARISON OF INFESTATION FROM 1927-1937 CAUSED BY THE MOUNTAIN PINE BEETLE IN LODGEPOLE PINE BEAVERHEAD NATIONAL FOREST -- 1937

Unit	Acreage	1927-30	1931	1932	1933	1934	1935	1936	1937
Pintlar	61,600	1,050,379						None	None
Mussigbrod	56,300							None	None
Battlefield	102,400							None	None
West Side	76,500							None	None
Jackson	75,800							None	None
Bloody Dick	108,160							Not over: 15,000	None
Horse Prairie	57,000							Not over: 9,000	None
Rattlesnake	68,400							63,270	10,602
Grasshopper	42,500							18,870	None
Warm Springs	54,500							11,500	None
East Side	86,200							None	None
Upper Wise River	142,800							24,990	None
Lower Wise River	59,000							10,325	None
Melrose	132,700							95,677	20,568
Lima	218,000							Not over: 7,000	None
Totals	1,341,860							255,632	31,170

The infestation for the Melrose and Rattlesnake units is only .155 tree per acre, with heavier concentrations in the two areas previously discussed, Birch Creek and Hock Creek. In whitebark pine the infestation averaged .251 tree per acre and was characterised by groups more or less large, while in the much greater lodgepole pine acreage the attacked trees averaged .116 per acre and were found as individual trees or in small groups.

In the Big Hole Basin 20 miles of strip run on three different areas and additional trees having fading foliage examined outside the strip revealed only a few living parent adults in a whitebark pine near the Dark Horse Mine. Even in that tree conditions indicated those few insects would be "pitched-out" as had occurred in other nearby trees.

An unexpected condition noted on Dark Horse Creek was the large proportion of an extensive area of mature lodgepole and whitebark pine which had escaped attack. Although considerable loss had occurred, there is still a stand on this area comparable to that on the Melrose and Rattlesnake units where losses have not been serious. Why so much of this stand survived as well as occasional small patches of timber in other places where losses in the surrounding timber have been heavy, is one of the riddles presented by the outbreak. The finding of groups and small areas of unattacked trees in the midst of heavily devastated stands is not unusual, but the area on Dark Horse Creek is unusually large. A study of tree growth and environment on this area and comparison

with adjacent ones where heavy loss has occurred, might shed some light on the reason for this survival.

Activity of Secondary Bark Beetles

On the Battlefield check strip bark beetle activity has reached an extremely low ebb. Not only were no mountain pine beetle attacks observed, but no trees previously damaged by them had been "filled-in" by secondary bark beetles in 1937. Pityogenes knechteli and associated insects had only attacked three trees, one 6 inches and the other two 4 inches in diameter, giving an average for the strip of .083 tree per acre, or a total of about 70,000 attacked trees for the approximate 840,000 acres comprising the timbered portion of the Big Hole Basin which it is considered representative of. Estimates on the basis of the Wise River and Elkhorn check strips show an average infestation by secondary insects of .276 tree per acre, or a total of 136,000 attacked trees on the rest of the main part of the forest. The trees in this last estimate averaged about 5 inches in diameter and they too were chiefly those previously unattacked by any bark beetles. In the area adjoining the Big Hole Basin it is believed the activity of secondary bark beetles has reached an endemic status, but that losses in the adjoining units to the east may still be classified as from a declining epidemic. The estimates of secondary activity since 1933 are shown in table III.

Table III

LOSSES DUE TO SECONDARY BARK BEETLES ON THE BEAVERHEAD FOREST 1933-1937

	1933	1934	1935	1936	1937
Number of trees attacked by secondary bark beetles:	958,558	7,383,098	4,395,093	1,637,000	208,000
Percent losses caused by secondaries are of total losses for year	53	85	94.5	92.7	87

Inspection of table III reveals how rapidly activity of Pityogenes knechteli and associated insects is decreasing, and the large proportion of the annual losses they have been causing.

Until the time of the decided reduction in the outbreak in 1932-1933 attacks by the mountain pine beetle of an increasing number of trees each year furnished ample material in the upper bole and branches for the completion of the life history of these secondary insects. The approximate 17,500,000 trees killed in 1932 absorbed most of the attacks of the secondaries in 1933, but the approximate 870,000 trees killed by the mountain pine beetle in 1933 were too few for the secondaries attacking in 1934, and they were forced to attack green trees of which they killed over 7,000,000. As these trees had not been "ready made" by the mountain pine beetle, they offered considerable resistance to attack by the secondaries with the latter undoubtedly suffering a very high mortality which has been repeated each year up to 1937.

Not only were these smaller bark beetles forced into many green trees by lack of their usual host material, but since 1933 they have

been observed heavily "filling-in" the lower bole of the trees at the time of or shortly after attack by the mountain pine beetle. The more rapid development of the secondaries permits them to consume or render the cambium layer of the tree unfit for food for the slower-developing mountain pine beetle larvae. Thus the secondaries became an important factor in reducing the mountain pine beetle brood, although by so doing they have decreased the number of trees subsequently attacked by the latter insect which are the preferred host material for secondary insects.

Similar instances of the decline in secondary bark beetle activity and their inability to maintain themselves when forced into host material not weakened by primary bark beetles or other factors have been observed and reported upon on many previous occasions.

Influence of Rainfall on Losses Caused by Secondary Bark Beetles

In studying the effect that precipitation during the growing season might have on an outbreak of the secondary bark beetles, data for May, June, July, and August for the years 1932 to 1937 at Wisdom, Montana were compared in figure I with the number of trees killed by secondaries for the period 1933 to 1937. It is felt, however, that the losses for 1934 to 1937 are the only ones that might show a direct correlation. In 1933 most of the secondary activity was in the tops and limbs of trees killed by the mountain pine beetle in 1932. Not until 1934 were the secondaries forced into unattacked timber because of no "ready made" material. In that year precipitation was

less than in 1933.

If increases in precipitation accelerate growth and increase the vigor and resistance of trees, we may logically expect a decrease in the number of insects successfully completing their life history in such trees. In addition the resistance would probably be so high as to cause heavy mortality among attacking insects. Conversely, it is natural to expect a decrease in precipitation to result in less resistance in the attacked trees, requiring fewer insects to make a successful attack, more trees to be attacked, and finally a heavier emergence.

Precipitation continued to decrease in 1935, but losses from secondary insects decreased instead of increasing, as would logically be expected. A sharp rise in precipitation in 1936 showed the expected trend in fewer trees killed, but a slight decrease in rainfall in 1937 failed to show the expected upward trend in losses.

With only one year's data showing the logical trend and two years' data contradicting it, it may be concluded that precipitation was not a major factor in the reduction of the outbreak of secondary bark beetles.

Conditions on the Check Strips

The Battlefield Strip

The slight activity of bark beetles on this strip and in the Big Hole Basin has been discussed in the preceding pages. Because

of no mountain pine beetle activity, this strip has outlived its original purpose of furnishing, at different times during the season of attack, an index of the percent of total attacks for that year. Valuable data can still be obtained, however, concerning the effect of the infestation on a lodgepole pine stand. Such data include the influence of destruction of more or less of the lodgepole pine in the stand on seedling production and growth, on future stand composition as judged from seedling species, on acceleration of growth of remaining green trees, and on rate of fall of killed trees with its resulting effect on the stand and on fire hazards.

Windthrow of insect-killed trees has been very light on this strip up to 1937, but a severe wind storm in September of that year resulted in an average of about 1.7 trees per acre being blown over. The heaviest windthrow had occurred on a steep south-facing slope, where on one acre 39 insect-killed trees were overthrown and killed three small green trees in their fall. Only 23 additional trees were blown over on the remaining 35 acres of the strip. Although the September storm doubtless caused an abnormal amount of windthrow, we may expect a general increase in the number of trees falling each year. As was to be expected, the trees which were first killed are least windfirm. In table IV the windthrow data up to autumn of 1937 and a comparison with the percent of trees killed annually over the period of the outbreak are shown.

Table IV

DIAMETER AND TIME OF KILL OF WINDTHROWN TREES
ON BATTLEFIELD CHECK STRIP

	1928-30	1931	1932	1933	1934
Percent of total trees killed by mountain pine beetle during	26.5	46.9	26.1	.4	.1
Percent of total windthrown trees up to 1937	48.4	22.6	19.3	8	1.6
Average diameter of trees windthrown	11.1	10.7	8.5	8	7.2

The preceding tabulation shows that while only slightly more than one quarter of the trees were killed from 1928-30, nearly half of those windthrown were of that period. Too large a percent of windthrow than kill is shown for 1933 and 1934, but lack of sufficient numbers is believed responsible for this unexpected trend.

The Wise River Strip

The mountain pine beetle has ceased activity on this strip, leaving a much greater proportion of unattacked lodgepole pine of larger diameter than on the Battlefield strip. This contrast in stand conditions is due to the different status of the infestation on these widely separated areas when the sudden decline in infestation took place over the forest as a whole in 1932-1933, followed by a general decrease since that time. By 1932 host material and consequently the larger trees had been greatly depleted and the infestation was decreasing on the Battlefield area, while on the Wise River drainage it was just beginning to be serious. A similar large amount of merchantable timber remains on the units to the south and east.

Activity of secondary bark beetles was found to be extremely low in 1937, only one tree having been attacked on the 40 acres of this strip. More secondary activity was noted adjoining the strip, but even with the addition of those trees the average over the drainage would be extremely low. Windthrow may be expected to be light and somewhat deferred as losses were light on this area until 1932. Furthermore, Douglas fir, unsusceptible to mountain pine beetle attack and comprising more or less of the stand, materially aids in preventing windthrow of the dead trees. Up to October of 1937 only two of the bark-beetle-killed trees had been windthrown.

The Elkhorn Strip.

No mountain pine beetle work for the 1937 season was observed on this strip, and secondary activity was less than in 1936. About 45 percent of the secondary work was in trees "green-sided" or "pitched-out" from mountain pine beetle attacks prior to 1937 and the remaining 55 percent in trees not previously attacked. Windthrow of eight insect-killed trees was noted and one green tree had been knocked over by a falling insect-killed tree.

The general area of which this strip is a part shows considerable survival of timber of the larger diameters.

Infestation on Other Parts of the Beaverhead Forest

Although there are no data for the Blacktail Hills or the Tobacco Root Mountains, the Gravelly Range adjoining them showed an infestation of 1.47 trees per acre. This average is probably represen-

tative of the high areas, but for the region as a whole somewhat less than one tree per acre is probably nearer the average.

In general, the infestation is declining over this portion of the forest, remaining however somewhat concentrated in whitebark pine and quite active in a few small areas where severe frost kill has resulted in more or less defoliation and weakening of the trees, thereby attracting the mountain pine beetle.

The Infestation on the Targhee Forest

Data for the entire Targhee Forest are lacking, but judging from the check strip near Antelope Flat fewer trees were attacked in 1937 than in 1936. In 1934 there were 9.975 trees per acre attacked, in 1935 an increase to 11.975, in 1936 a decrease to 6.575, and in 1937 only 1.175. Of this last total the average number of trees attacked in 1937 by the mountain pine beetle was only .050 per acre. Most of the loss in 1937 was of trees previously attacked, 33 of the 47 trees attacked being such "fill-ins" by secondary bark beetles. A table of the data for the three years from the check strip follows.

Table V

COMPARISON OF BARK BEETLE ATTACKS ON ASHTON CHECK STRIP IN 1935, 1936, AND 1937

Year	1935	1936	1937
Total trees attacked	479	263	47
Percent killed by Ips sp. and other bark beetles	1	29.6	93.7
Percent killed by Dm.	50.1	20.8	4.3
Percent green-sided and pitched-out from Dm. and secondary bark beetle attack	48.9	49.4	2

From the preceding table the decided reduction in mountain pine beetle activity is clearly seen. In 1935, 240 trees were attacked by the mountain pine beetle on the strip and another 234 were attacked but not killed. In 1937 only two were killed and none unsuccessfully attacked. Where only 5 trees were killed in 1935 by Ips sp. and other small bark beetles, 44 were killed and 1 unsuccessfully attacked in 1937.

At Dry Creek, near McGinn's Ranch, 20 acres of strip yielded one tree killed and six unsuccessfully attacked by the mountain pine beetle. All trees were lightly attacked and might not even have attracted the insects had they not been seriously weakened by heavy defoliation due to frost injury. Regardless of the probable increase in number of attacked trees due to the attraction exerted by their weakened condition they averaged but .350 per acre, of which only .05 per acre had been killed. Surprisingly, this is the same number killed by the mountain pine beetle on the check strip 25 miles to the southwest. If the data from the two areas are representative of the forest as a whole, the infestation is rapidly declining toward an endemic status.

CONCLUSIONS

The active stage of the mountain pine beetle infestation on the main portion of the Beaverhead Forest seems to be past, although a light outbreak is still present on two of the eastern units. Secondary bark beetles have practically ceased activity on the units adjoining the Big Hole Basin. On the eastern units of this main part of the forest heavier but decreasing losses are occurring. The other parts of the Beaverhead to the east and southeast still support a light mountain pine beetle outbreak, but it too is decreasing rapidly. Direct losses due to bark beetles are probably past, but the effects will be felt for many decades. The dead stand remaining presents probably the greatest problem. On the Pintlar unit some mountain-pine-beetle-infested lodgepole pine treated in 1914 were still standing in 1934. We can expect the windthrow of trees from the recent outbreak to extend over as long a period. When these trees finally fall, they not only increase the fire hazard but may destroy some of the remaining green trees in their fall. Road, trail, telephone line, and stock driveway maintenance all will increase in cost because of the many windthrown trees to be removed. Fire protection and suppression costs can be expected to be higher for a number of decades. Stand composition may change from what was almost pure lodgepole pine to one in which Douglas fir and other species are in much larger proportion.

SUMMARY

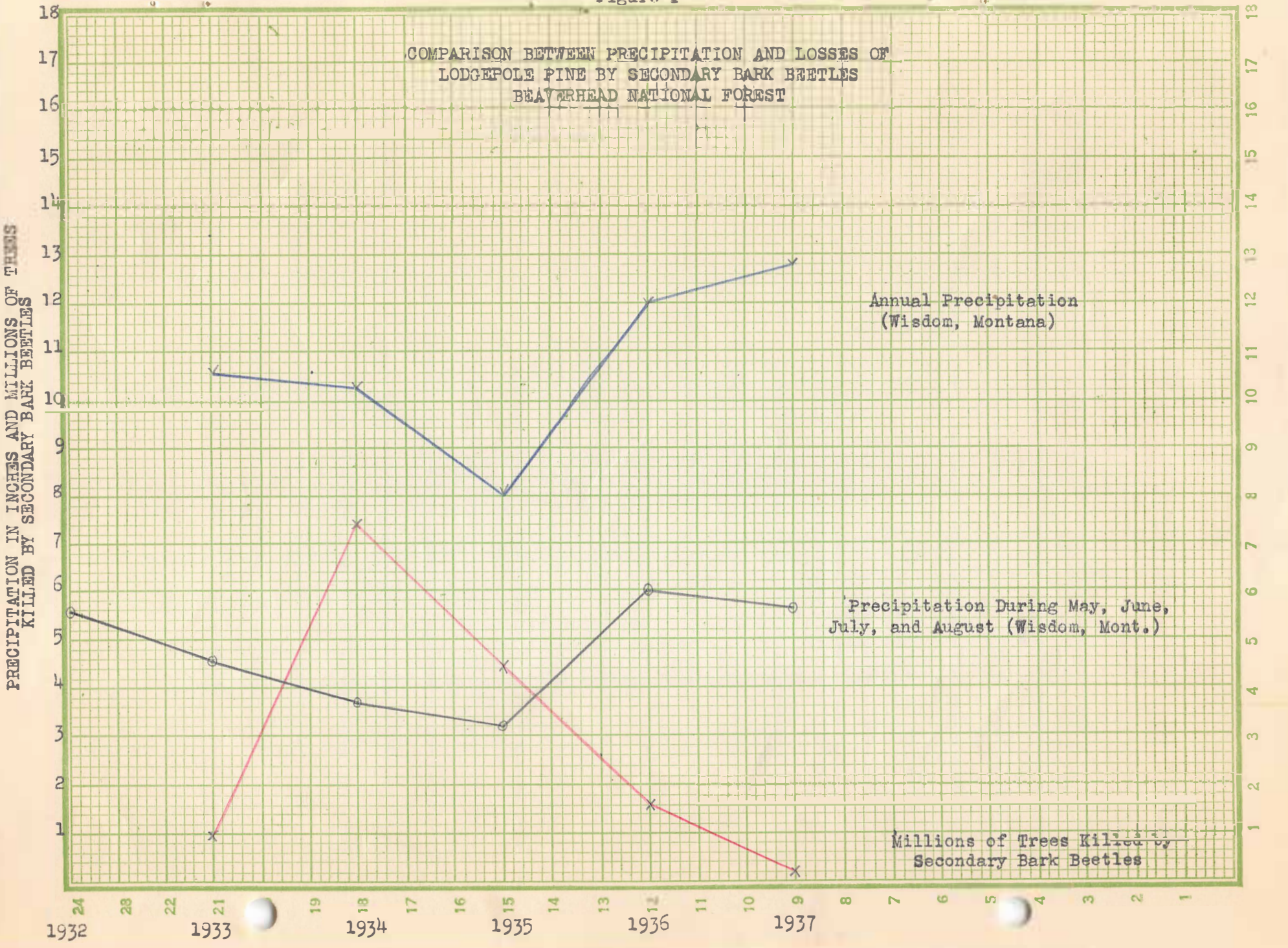
Losses from both the mountain pine beetle and secondary bark beetles are rapidly decreasing over the Beaverhead Forest. Only two

units on the main forest show any infestation, and that is very light. The portions of the forest to the east and southeast support a slightly heavier but declining infestation. The Targhee Forest adjoining the Beaverhead on the south also shows a decrease in mountain pine beetle infestation.

Respectfully submitted,

A. L. Gibson
Assistant Entomologist

Figure I


COMPARISON BETWEEN PRECIPITATION AND LOSSES OF
LODGEPOLE PINE BY SECONDARY BARK BEETLES
BEAVERHEAD NATIONAL FOREST
PRECIPITATION IN INCHES AND MILLIONS OF TREES
KILLED BY SECONDARY BARK BEETLES
Annual Precipitation
(Wisdom, Montana)
Precipitation During May, June,
July, and August (Wisdom, Mont.)
Millions of Trees Killed by
Secondary Bark Beetles
1932
1933
1934
1935
1936
1937